I possess very many drawings exhibiting the arrangement mentioned by REMUSAT ; but all subservient to mere ritual purposes, and consequently worthy of no serious attention. The *Matantara,* or variorum text of the *pujarís* of the present day, displays an infinite variety of formulæ*, illustrated by corresponding sculptural and pictorial devices, embodied in those works, and transferred from them to the walls and interior of temples existing all over the valley of Nepál.

[*To be continued.*]

III.—*Sivatherium Giganteum, a new Fossil Ruminant Genus, from the Valley of the Markanda, in the Siválik branch of the Sub-Himálayan Mountains. By* HUGH FALCONER, *M. D. Superintendent Botanical Garden, Seháranpur, and Captain* P. T. CAUTLEY, *Superintendent Doáb Canal.*

[The fossil here described is of such importance that we make no apology for reprinting the following article entire from the outcoming volume of the Physical Researches of the Society, having prepared the engraving of the head, so as to serve both editions : it should be remarked, in regard to the engraving, that the figure of the palate and teeth is on rather a larger scale than the rest.—ED.]

The fossil which we are about to describe forms a new accession to extinct Zoology. This circumstance alone would give much interest to it. But in addition, the large size, surpassing the rhinocreos ; the family of Mammalia to which it belongs ; and the forms of structure which it exhibits ; render the *Sivatherium* one of the most remarkable of the past tenants of the globe, that have hitherto been detected in the more recent strata.

Of the numerous fossil mammiferous genera discovered and established by CUVIER, all were confined to the Pachydermata. The species belonging to other families have all their living representatives on the earth. Among the Ruminantia, no remarkable deviation from existing types has hitherto been discovered, the fossil being closely allied to living species. The isolated position, however, of the Giraffe and the Camelidæ, made it probable, that certain genera had become extinct, which formed the connecting links between those and the other genera of the family, and further between the Ruminantia and the Pachydermata. In the Sivatherium† we have a ruminant of this description connecting the family with

* See the classified enumeration of the principal objects of *Buddha* worship appended to this paper. Appendix B.

† We have named the fossil, *Sivatherium,* from SIVA, the Hindú god, and *θηριον bellua.* The *Siválik* or Sub-Himálayan range of hills, is considered in the Hindu mythology, as the *Lútiah* or edge of the roof of SIVA's dwelling in the *Himálaya,* and hence they are called the *Siva-ala* or *Sib-ala,* which by an easy transition of sound became the *Sewálik* of the English. The fossil has been discovered in a tract which may be included in the *Sewálik* range, and we have given the name of Sivatherium to it, to commemorate this remarkable formation so rich in new animals. Another derivation of the name of the hills, as explained by the *Mahant* or High Priest at *Dehra,* is as follows :

Sewálik a corruption of *Siva-wála,* a name given to the tract of mountains between the Jumna and Ganges, from having been the residence of Iswara SIVA and his son GANE's, who under the form of an Elephant had charge of the Westerly portion from the village of *Dúdhli* to the Jumna, which portion is also called *Gangaja, gaja* being in Hindí an Elephant. That portion Eastward from *Dúdhli,* or between that village and *Haridwár,* is called *Deodhar,* from its being the especial residence of *Deota* or Iswara SIVA : the whole tract however between the Jumna and Ganges is called *Siva-ala,* or the habitation of SIVA : unde der. *Sewálik.*

the Pachydermata, and at the same time so marked by individual peculiarities as to be without an analogue in its order.

The fossil remain of the Sivatherium, from which our description is taken, is a remarkably perfect head. When discovered, it was fortunately so completely enveloped by a mass of stone, that although it had long been exposed to be acted upon as a boulder in a water-course, all the more important parts of structure had been preserved. The block might have been passed over, but for an edging of the teeth in relief from it, which gave promise of something additional concealed. After much labour, the hard crystalline covering of stone was so successfully removed, that the huge head now stands out with a couple of horns between the orbits, broken only near their tips, and the nasal bones projected in a free arch, high above the chaffron. All the molars on both sides of the jaw are present and singularly perfect. The only mutilation is at the vertex of the cranium, where the plane of the occipital meets that of the brow: and at the muzzle, which is truncated a little way in front of the first molar. The only parts which are still concealed, are a portion of the occipital, the zygomatic fossæ on both sides, and the base of the cranium over the sphœnoid bone.

The form of the head is so singular and grotesque, that the first glance at it strikes one with surprise. The prominent features are—1st, the great size, approaching that of the elephant: 2d, the immense developement and width of the cranium behind the orbits: 3d, the two divergent osseous cores for horns starting out from the brow between the orbits: 4th, the form and direction of the nasal bones, rising with great prominence out of the chaffron, and overhanging the external nostrils in a pointed arch: 5th, the great massiveness, width and shortness of the face forward from the orbits: 6th, the great angle at which the grinding plane of the molars deviates upwards from that of the base of the skull.

Viewed in lateral profile, the form and direction of the horns, and the rise and sweep in the bones of the nose, give a character to the head widely differing from that of any other animal. The nose looks something like that of the rhinoceros; but the resemblance is deceptive, and only owing to the muzzle being truncated. Seen from in front, the head is somewhat wedge-shaped, the greatest width being at the vertex and thence gradually compressed towards the muzzle; with contraction only at two points behind the orbits and under the molars. The zygomatic arches are almost concealed, and nowise prominent: the brow is broad, and flat, and swelling laterally into two convexities; the orbits are wide apart, and have the appearance of being thrown far forward, from the great production of the frontal upwards. There are no crest or ridges: the surface of the cranium is smooth, the lines are in curves, with no angularity. From the vertex to the root of the nose, the plane of the brow is in a straight line, with a slight rise between the horns. The accompanying drawings will at once give a better idea of the form than any description.

Now in detail of individual parts; and to commence with the most important and characteristic, the teeth:

There are six molars on either side of the upper jaw. The third of the series, or last milk molar, has given place to the corresponding permanent tooth, the detrition of which and of the last molar is well advanced, and indicates the animal to have been more than adult.

The teeth are in every respect those of a ruminant, with some slight individual peculiarities.

The three posterior or double molars are composed of two portions or semi-cylinders, each of which incloses, when partially worn down, a double crescent of enamel, the convexity of which is turned inwards. The last molar, as is normal in ruminants, has no additional complication, like that

in the corresponding tooth of the lower jaw. The plane of grinding slopes from the outer margin inwards. The general form is exactly that of an ox or camel. on a large scale. The ridges of enamel are unequally in relief, and the hollows between them unequally scooped. Each semi-cylinder has its outer surface, in horizontal section, formed of three salient knuckles, with two intermediate sinuses; and its inner surface, of a simple arch or curve. But there are certain peculiarities by which the teeth differ from those of other ruminants.

In correspondence with the shortness of jaw, the width of the teeth is much greater in proportion to the length than is usual in the family: the width of the third and fourth molars being to the length as 2.24 and 2.2 to 1.55 and 1.68 inches, respectively: and the average width of the whole series being to the length as 2.13 to 1.76 inches. Their form is less prismatic: the base of the shaft swelling out into a bulge or collar, from which the inner surface slopes outward as it rises: so that the coronal becomes somewhat contracted: in the third molar, the width at the coronal is 1.93, at the bulge of the shaft 2.24. The ridges and hollows on the outer surface descend less upon the shaft, and disappear upon the bulge. There are no accessary pillars on the furrow of junction at the inner side. The crescentic plates of enamel have a character which distinguishes them from all known ruminants: the inner crescent, instead of sweeping in a nearly simple curve, runs zig-zag-wise in large sinuous flexures, somewhat resembling the form in the Elasmotherium.

The three double molars differ from each other only in their relative states of wearing. The antepenultimate, being most worn, has the crescentic plates less curved, more approximate and less distinct: the penultimate and last molars are less worn, and have the markings more distinct.

The three anterior or simple molars have the usual form, which holds in Ruminantia, a single semi-cylinder, with but one pair of crescents. The first one is much worn and partly mutilated: the second is more entire, having been a shorter time in use, and finely exhibits the flexuous curves in the sweep of the enamel of the inner crescent: the last one has the simple form of the permanent tooth, which replaces the last milk molar: it also shews the wavy form of the enamel.

Regarding the position of the teeth in the jaw; the last four molars, viz. the three permanent and the last of replacement, run in a straight line, and on the opposite sides are parallel and equi-distant: the two anterior ones are suddenly directed inwards, so as to be a good deal approximated. If the two first molars were not thus inflected, the opposite lines of teeth would form exactly two sides of a square: the length of the line of teeth, and the intervals between the outer surfaces of the four last molars, being almost equal, viz. 9.8 and 9.9 inches respectively.

The plane of detrition of the whole series of molars from rear to front is not horizontal, but in a slight curve, and directed upwards at a considerable angle with the base of the skull: so that when the head is placed, so as to rest upon the occipital condyles and the last molars, a plane through these points is cut by a chord along the curve of detrition of the whole series of molars at an angle of about 45°. This is one of the marked characters about the head:

Dimensions of the Teeth.	*Length. Inches.*	*Breadth. Inches.*
Last molar right side,	——	2.35
Penultimate do.	2.20	2.38
Antepenultimate do.	1.68	2.20
Last simple molar,	1.55	2.24
Second do. do.	1.70	1.95
First do. do.	1.70	1.90

	Outer Surfaces.	*Inner Surfaces.*
Interval between the surfaces of last molar,	9.9	5.5
Do. do. do. third molar,	9.8	5.5
Do. do. do. second do.	8.4	4.5
Do. do. do. first do.	6.4	3.2

Space occupied by the line of molars 9.8 inches.

Bones of the Head and Face.—From the age of the animal to which the head had belonged, the bones had become anchylosed at their commissures, so that every trace of suture has disappeared, and their limits and connections are not distinguishable.

The frontal is broad and flat, and slightly concave at its upper half. It expands laterally into two considerable swellings at the vertex, and sweeps down to join the temporals in an ample curve; and with no angularity. It becomes narrower forwards, to behind the orbits; and then expands again in sending off an apophysis to join with the malar bone, and complete the posterior circuit of the orbit. The width of the bone where narrowest, behind the orbit, is very great, being 16.2 inches. Partly between and partly to the rear of the orbits, there arise by a broad base, passing insensibly into the frontal, two short thick conical processes. They taper rapidly to a point, a little way below which they are mutilated in the fossil. They start so erect from the brow, that their axis is perpendicular to their basement: and they diverge at a considerable angle. From their base upwards they are free from any rugosities, their surface being smooth and even. They are evidently the osseous cores of two intra-orbital horns. From their position and size they form one of the most remarkable features in the head. The connections of the frontal are nowhere distinguishable, no mark of a suture remaining. At the upper end of the bone the skull is fractured, and the structure of the bone is exposed. The internal and outer plates are seen to be widely separated, and the interval to be occupied by large shells, formed by an expansion of the diploe into plates, as in the elephant. The interval exceeds 2½ inches in the occipital. On the left side of the frontal, the swelling at the vertex, has its upper lamina of bone removed, and the cast of the cells exhibits a surface of almond-shaped or oblong eminences, with smooth hollows between.

The temporal is greatly concealed by a quantity of the stony matrix, which has not been removed from the temporal fossa. No trace of the squamous suture remains to mark its limits and connection with the frontal. The inferior processes of the bone about the auditory foramen have been destroyed, or are concealed by stone. The zygomatic process is long, and runs forward to join the corresponding apophysis of the jugal bone, with little prominence or convexity. A line produced along it would pass in front, through the tuberosities of the maxillaries, and to the rear along the upper margin of the occipital condyles. The process is stout and thick. The temporal fossa is very long, and rather shallow. It does not rise up high on the side of the cranium: it is overarched by the cylinder-like sides of the frontal bone. The position and form of the articulating surface with the lower jaw are concealed by stone which has not been removed.

There is nothing in the fossil to enable us to determine the form and limits of the parietal bones; the cranium being chiefly mutilated in the region which they occupy. But they appear to have had the same form and character as in the ox: to have been intimately united with the occipitals, and to have joined with the frontal at the upper angle of the skull.

The form and characters of the occipital are very marked. It occupies a large space, having width proportioned to that of the frontal, and considerable height. It is expanded laterally into two alæ, which com-

mence at the upper margin of the foramen magnum, and proceed upwards and outwards. These alæ are smooth, and are hollowed out downwards and outwards from near the condyles towards the mastoid region of the temporal. Their inner or axine margins proceed in a ridge arising from the border of the occipital foramen, diverging from each other nearly at right angles, and enclose a large triangular fossa into which they descend abruptly. This fossa is chiefly occupied by stone in the fossil, but it does not appear shallow, and seems a modification of the same structure as in the elephant. There is no appearance of an occipital crest or protuberance. The bone is mutilated at the sides towards the junction with the temporals. Both here and at its upper fractured margin its structure is seen to be formed of large cells with the diploe expanded into plates, and the outer and inner laminæ wide apart. This character is very marked at its upper margin, where its cells appear to join on with those of the frontal. The condyles are very large, and fortunately very perfect in the fossil; the longest diameter of each is 4.4 inches, and the distance measured across the foramen magnum, from their outer angles, is 7.4 inches: dimensions exceeding those of the elephant. Their form is exactly as in the Ruminantia, viz. their outer surface composed of two convexities meeting at a rounded angle: one in the line of the long axis, stretching obliquely backwards from the anterior border of the foramen magnum; on the other forwards and upwards from the posterior margin, their line of commissure being in the direction of the transverse diameter of the foramen. The latter is also of large size, its antero-posterior diameter being 2.3 inches, and the transverse diameter 2.6 inches. The large dimensions of the foramen and condyles must entail a corresponding developement in the vertebræ, and modify the form of the neck and anterior extremities.

The sphenoidal bone, and all the parts along the base of the skull from the occipital foramen to the palate, are either removed, or so concealed by stone, as to give no characters for description.

The part of the brow from which the nasal bones commence is not distinguishable. The suture connecting them with the frontal is completely obliterated: and it is not seen whether they run up into a sinus in that bone, or how they join on with it. Between the horns there is a rise in the brow, which sinks again a little forward. A short way in advance of a line connecting the anterior angles of the orbits, there is another rise in the brow. From this point, which may be considered their base, the nasal bones commence ascending from the plane of the brow, at a considerable angle. They are broad and well arched at their base, and proceed forward with a convex outline, getting rapidly narrower, to terminate in a point curved downwards, which overhangs the external nostrils. For a considerable part of their length they are joined to the maxillaries: but forwards from the point where they commence narrowing, their lower edge is free and separated from the maxillaries by a wide sinus: so that viewed in lateral profile their form very much resembles the upper mandible of a hawk, detached from the lower. Unluckily in the fossil, the anterior margins of the maxillaries are mutilated, so that the exact length of the nasal bone that was free from connection with them cannot be determined. As the fossil stands, about four inches of the lower edge of the nasals, measured along the curve, are free. The same mutilation prevents its being seen how near the incisives approached the nasals, with which they do not appear to have been joined. This point is one of great importance, from the structure it implies in the soft parts about the nose. The height and form of the nasal bones, are the most remarkable feature in the head: viewed from above they are seen to taper rapidly from a broad base to a sharp point; and the vertical height of their most convex part above the brow at their base, is $3\frac{1}{2}$ inches.

The form of the maxillaries is strongly marked in two respects: 1st, their shortness compared with their great width and depth: 2nd, in the upward direction of the line of alveoli from the last molar forwards, giving the appearance (with the licence of language intended to convey an idea of resemblance without implying more) as if the face had been pushed upwards to correspond with the rise in the nasals; or fixed on at an angle with the base of the cranium. The tendency to shortness of the jaw was observed in the dimensions of the teeth, the molars being compressed, and their width exceeding their length to an extent not usual in the Ruminantia. The width apart, between the maxillaries, was noticed before; the interval, between the outer surfaces of the alveoli, equalling the space in length occupied by the line of molars. The cheek tuberosities are very large and prominent, their diameter at the base being 2 inches, and the width of the jaw over them being 12.2 inches, whereas at the alveoli it is but 9.8 inches. They are situated over the third and fourth molars; and proceeding up from them towards the malar, there is an indistinct ridge on the bone. The infra-orbitary foramen is of large size, its vertical diameter being 1.2 inch; it is placed over the first molar, as in the ox and deer tribe. The muzzle portion of the bone is broken off at about 2.8 inches from the 1st molar, from the alveolar margin of which, to the surface of the diastema, there is an abrupt sink of 1.7 inch. The muzzle is here contracted to 5.8 inches, and forwards at the truncated part to about 4.1. The palatine arch is convex from rear to front, and concave across. No trace of the palatine foramina remains, nor of the suture with the proper palatine bones. The sphœno-palatine apophyses and all back to the foramen magnum* are either removed or concealed in stone. In front, the mutilation of the bone, at the muzzle, does not allow it to be seen, how the incisive bones were connected with the maxillaries: but it appears that they did not reach so high on the maxillaries as the union of the latter with the nasals. The same cause has rendered obscure the connexions of the maxillaries with the nasals, and the depth and size of the nasal echancrure or sinus.

The jugal bone is deep, massive and rather prominent. Its lower border falls off abruptly in a hollow descending on the maxillaries: the upper enters largely into the formation of the orbit. The posterior orbital process unites with a corresponding apophysis of the frontal, to complete the circuit of the orbit behind. The zygomatic apophysis is stout and thick, and rather flat. No part of the arch, either in the temporal or jugal portions, is prominent: the interval between the most salient points being greatly less than the hind part of the cranium, and slightly less than the width between the bodies of the jugals.

The extent and form of the lachrymals, cannot be made out, as there is no trace of a suture remaining. Upon the fossil, the surface of the lachrymary region passes smoothly into that of the adjoining bones. There is no perforation of the lower and anterior margin of the orbit by lachrymary foramina, nor any hollow below it indicating an infra-orbital or lachrymary sinus. It may be also added, what was omitted before, that there is no trace of a superciliary foramen upon the frontal.

The orbits are placed far forwards, in consequence of the great production of the cranium upwards, and the shortness of the bones of the face. Their position is also rather low, their centre being about 3.6 inches below the plane of the brow. From a little injury done in chiseling off the stone, the form or circle of the different orbits does not exactly correspond. In the one of the left side, which is the more perfect, the long

* With the exception of a portion of the basilary region, which resembles that of the Ruminants.

axis makes a small angle with that of the plane of the brow: the antero-posterior diameter is 3.3 inches, and the vertical 2.7 inches. There is no prominence or inequality in the rim of the orbits, as in the Ruminantia. The plane of the rim is very oblique: the interval between the upper or frontal margins of the two orbits being 12.2 inches, and that of the lower or molar margin 16.2 inches.

* *Dimensions of the Skull of the Sivatherium Giganteum.*

	Eng. Inches.	*Métres.*
From the anterior margin of the foramen magnum to the alveolus of 1st molar,	18.85	.478
From do. to the truncated extremity of the muzzle,	20.6	.5268
From do. to the posterior margin of the last molar,	10.3	.262
From the tip of the nasals to the upper fractured margin of the cranium,	18.0	.4568
From do. do. to do. along the curve,	19.0	.4822
From do. do. along the curve, to where the nasal arch begins to rise from the brow,	7.8	.198
From the latter point to the fractured margin of the cranium,	11.2	.284
From the tip of the nasals to a chord across the tips of the horns,	8.5	.216
From the anterior angle, right orbit, to the first molar,	9.9	.251
From the posterior do. do. to the fractured margin of the cranium,	12.1	.3075
Width of cranium at the vertex (mutilation at left side restored), about	22.0	.559
Do. between the orbits, upper borders,	12.2	.3095
Do. do. lower borders,	16.2	.4108
Do. behind the orbits at the contraction of the frontal,	14.6	.3705
Do. between the middle of the zygomatic arches,	16.4	.4168
Do. between the bodies of the malar bones,	16.62	.422
Do. base of the skull behind the mastoid processes (mutilated on both sides),	19.5	.496
Do. between the cheek tuberosities of the maxillaries,	12.2	.3095
Do. of muzzle portion of the maxillaries in front of the first molar,	5.8	.149
Do. of do. where truncated (partly restored),	4.1	.104
Do. between the outer surfaces of the horns at their base,	12.5	.312
Do. do. do. fractured tips of ditto,	13.65	.347
Perpendicular from a chord across tips of do. to the brow,	4.2	.165
Depth from the convexity of the occipital condyles to middle of frontal behind the horns,	11.9	.302
Do. from the body of the sphœnoidal to do. between the horns,	9.94	.252
Do. from middle of the palate between the 3rd and 4th molars do. at root of the nasals,	7.52	.192
Do. from posterior surface last molar to extremity of the nasals,	13.0	.331
Do. from grinding surface penultimate molar to root of the nasals,	10.3	.262
Do. from the convexity near the tip of the nasals to the palatial surface in front of the first molar,	5.53	.14
Depth from middle of the alæ of the occipital to the swell at vertex of frontal,	8.98	.228
Do. from inferior margin of the orbit to grinding surface 5th molar,	7.3	.186
Do. from the grinding surface 1st molar to edge of the palate in front of it,	2.6	.066
Space from the anterior angle of orbit to tip of the nasals,	10.2	.2595
Antero-posterior diameter left orbit,	3.3	.084
Vertical do. do.	2.7	.0685
Antero-posterior diameter of the foramen magnum,	2.3	.058
Transverse do. do.	2.6	.066
Long diameter of each condyle,	4.4	.112
Short or transverse do. of do.	2.4	.0603
Interval between the external angles of do. measured across the foramen,	7.4	.188

Among a quantity of bones collected in the neighbourhood of the spot in which the skull was found, there is a fragment of the lower jaw of a very large ruminant, which we have no doubt belonged to the Sivatherium:

* To facilitate comparison with the large animals described in CUVIER'S Ossemen Fossiles, the dimensions are also given in French measure.

and it is even not improbable that it came from the same individual with the head described. It consists of the hind portion of the right jaw, broken off at the anterior third of the last molar. The coronoid apophysis, the condyle, with the corresponding part of the ramus, and a portion of the angle are also removed. The two posterior thirds only, of the last molar remain; the grinding surface partly mutilated, but sufficiently distinct to show the crescentic plates of enamel, and prove that the tooth belonged to a ruminant. The outline of the jaw in vertical section, is a compressed ellipse, and the outer surface more convex than the inner. The bone thins off, on the inner side towards the angle of the jaw, into a large and well marked muscular hollow: and running up from the latter, upon the ramus towards the foramen of the artery, there is a well defined furrow, as in the Ruminantia. The surface of the tooth is covered with very small rugosities, and striæ, as in the upper molars of the head. It had been composed of three semi-cylinders, as is normal in the family, and the advanced state of its wearing proves the animal from which it proceeded to have been more than adult.

The form and relative proportions of the jaw agree very closely with those of the corresponding parts of a buffalo. The dimensions compared with those of the buffalo and camel are thus:

	Sivatherium.	*Buffalo.*	*Camel.*
Depth of the jaw from the alveolus last molar,....	4.95 inch.	2.65 inch.	2.70 inch.
Greatest thickness of do.	2.3	1.05	1.4
Width of middle of last molar, ...	1.35	0.64	0.76
Length of posterior $\frac{2}{3}$d of do.	2.15	0.95	1.15

No known ruminant, fossil or existing, has a jaw of such large size; the average dimensions above given being more than double those of a Buffalo, which measured in length of head 19.2 inches (.489 mètres); and exceeding those of the corresponding parts of the rhinoceros. We have therefore no hesitation in referring the fragment to the Sivatherium Giganteum.

The above comprises all that we know regarding the osteology of the head from an actual examination of the parts. We have not been so fortunate hitherto, as to meet with any other remain, comprising the anterior part of the muzzle either of the upper or lower jaw*. We shall now proceed to deduce the form of the deficient parts, and the structure of the head generally, to the extent that may be legitimately inferred, from the data of which we are in possession.

Notwithstanding the singularly perfect condition of the head, for an organic remain of such enormous size, we cannot but regret the mutilation at the muzzle and vertex, as it throws a doubt upon some very interesting points of structure in the Sivatherium: 1st, the presence or absence of incisive and canine teeth in the upper jaw, and their number and character if present; 2nd, the number and extent of the bones which enter into the basis of the external nostrils; and 3rd, the presence or absence of two horns on the vertex, besides the two intra-orbital ones.

* In a note received from Captain CAUTLEY while this paper is in the press, that gentleman mentions the discovery of a portion of the skeleton of a Sivatherium in another part of the hills: *See Journal As. Soc. Vol. IV.* "During my recent trip to the *Siwáliks* near the Pinjôr valley, the field of Messrs. BAKER and DURAND'S labours, I regretted much my inability to obtain the dimensions of one of the most superb fossils I suppose that ever was found. It was unfortunately discovered and excavated by a party of work people employed by a gentleman with whom I was unacquainted; and although I saw the fossil when in the rock, I was prevented from getting the measurements afterwards. This specimen appeared to consist of the femur and tibia, with the tarsal, metatarsal, and phalanges of our Sivatherium." It is much to be regretted that such an opportunity should have been lost of adding to the information already acquired of this new and gigantic Ruminant.—SEC.

Regarding the first point, we have nothing sufficient to guide us with certainty to a conclusion, as there are ruminants both with and without incisives and canines in the upper jaw; and the Sivatherium differs most materially in structure from both sections. But there are two conditions of analogy which render it probable that there were no incisives. 1. In all ruminants which have the molars in a contiguous and normal series, and which have horns on the brow, there are no incisive teeth. In the camel and its congeners, where the anterior molars is unsymmetrical and separated from the rest of the series by an interval, incisives are present in the upper jaw. The Sivatherium had horns, and its molars were in a contiguous series: it is therefore probable that it had no incisives. Regarding the canines there is no clue to a conjecture, as there are species in the same genus of ruminants both with and without them. 2. The extent and connections of the incisive bones are points of great interest, from the kind of developement which they imply in the soft parts appended to them.

In most of the horned ruminantia, the incisives run up by a narrow apophysis along the anterior margins of the maxillary bones, and join on to a portion of the sides of the nasals; so that the bony basis of the external nostrils is formed of but two pairs of bones, the nasals and the incisives. In the camel, the apophyses of the incisives terminate upon the maxillaries without reaching the nasals, and there are three pairs of bones to the external nostrils, the nasals, maxillaries and incisives. But neither in the horned ruminants, nor in the camel and its congeners, do the bones of the nose rise out of the plane of the brow with any remarkable degree of saliency, nor are their lower margins free to any great extent towards the apex. They are long slips of bone, with nearly parallel edges, running between the upper borders of the maxillaries, and joined to the ascending process of the incisive bone, near their extremity, or connected only with the maxillaries; but in neither case projecting so as to form any considerable re-entering angle, or sinus, with these bones.

In our fossil, the form and connections of the nasal bones, are very different. Instead of running forward in the same plane with the brow, they rise from it at a rounded angle of about 130°, an amount of saliency without example among ruminants, and exceeding what holds in the rhinoceros, tapir, and palæotherium, the only herbivorous animals with this sort of structure. Instead of being in nearly parallel slips, they are broad and well arched at their base, and converge rapidly to a sharp tip, which is hooked downwards, over-arching the external nostrils. Along a considerable portion of their length they are unconnected with the adjoining bones, their lower margins being free and so wide apart from the maxillaries, as to leave a gap or sinus of considerable length and depth in the bony parietes of the nostrils. The exact extent to which they are free, is unluckily not shown in the fossil, as the anterior margin of the maxillaries is mutilated on both sides, and the connection with the incisives destroyed. But as the nasal bones shoot forward beyond the mutilated edge of the maxillaries, this circumstance, together with their well defined outline and symmetry on both sides of the fossil, and their rapid convergence to a point with some convexity, leaves not a doubt that they were free to a great extent and unconnected with the incisives.

Now to determine the conditions in the fleshy parts, which the structure in the bony parietes of the nostrils entails.

The analogies are to be sought for in the ruminantia and pachydermata.

The remarkable saliency of the bones of the nose, in the Sivatherium, has no parallel, in known ruminants, to guide us; and the connection of the nasals with the incisives, or the reverse, does not imply any important difference in structure in the family. In the Bovine section, the Ox and the Buffalo have the nasals and incisives connected: whereas they are

separate in the Yák* and Aurochs. In the Camel, they are also separate, and this animal has greater mobility in the upper lip than is found in other ruminants.

In the Pachydermata, both these conditions of structure are present and wanting in different genera ; and their presence or absence is accompanied with very important differences in the form of the corresponding soft parts. It is therefore in this family that we are to look for an explanation of what is found in the Sivatherium.

In the Elephant and Mastodon, the Tapir, Rhinoceros, and Palæotherium, there are three pairs of bones to the external nostrils ; the nasals, the maxillaries, and incisives†. In all these animals, the upper lip is highly developed, so as to be prehensile, as in the Rhinoceros, or extended into a trunk, as in the Elephant and Tapir ; the amount of developement being accompanied with corresponding difference in the position and form of the nasal bones. In the Rhinoceros, they are long and thick, extending to the point of the muzzle, and of great strength to support the horns of the animal : and the upper lip is broad, thick, and very mobile, but little elongated. In the Elephant, they are very short, and the incisives enormously developed for the insertion of the tusks, and the trunk is of great length. In the Tapir, they are short and free, except at the base, and projected high above the maxillaries ; and the structure is accompanied by a well developed trunk. In the other Pachydermatous genera, there are but two pairs of bones to the external nostrils, the nasals and the incisives : the latter running up so as to join on with the former ; and the nasals, instead of being short and salient, with a sinus laterally between them and the maxillaries, are long, and run forward, united to the maxillaries, more or less resembling the nearly parallel slips of the Ruminantia. Of this genera, the Horse has the upper lip endowed with considerable mobility ; and the lower end of the nasals is at the same time free to a small extent. In all the other genera, there is nothing resembling a prehensile organ in the upper lip.

In the Sivatherium, the same kind of structure holds, as is found in the Pachydermata with trunks. Of these it most nearly resembles the Tapir. It differs chiefly in the bones of the nose being larger and more salient from the Chaffron ; and in there being less width and depth to the naso-maxillary sinus, than the Tapir exhibits. But as the essential points of structure are alike in both, there is no doubt that the Sivatherium was invested with a trunk like the Tapir.

This conclusion is further borne out by other analogies, although more indirect than that afforded by the nasal bones.

1st.—The large size of the infra-orbitary foramen. In the fossil, the exact dimensions are indistinct, from the margin having been injured in the chiseling off of the matrix of stone : the vertical diameter we make out to be 1.2 inch, which perhaps may be somewhat greater than the truth ; but any thing approaching this size, would indicate a large nerve for transmission, and a highly developed condition of the upper lip.

2nd.—The external plate of the bones of the cranium is widely separated from the inner, by an expansion of the diploe in vertical plates, forming large cells, as in the cranium of the Elephant : and the occipital is expanded laterally into alæ, with a considerale hollow between, as in the Elephant. Both these conditions are modifications of structure, adapted for supplying an extensive surface for muscular attachment, and imply a thick fleshy neck, with limited range of motion ; and, in more remote sequence, go to prove the necessity of a trunk.

* Cuvier. Ossemens Fossiles, tome iv. p. 131.
† Cuvier. Ossemens Fossiles, tome iii. p. 29.

3rd.—The very large size of the occipital condyles, which are greater both in proportion, and in actual measurement, than those of the Elephant, the interval between their outer angles, taken across the occipital foramen, being 7.4 inches. The atlas, and the rest of the series of cervical vertebræ, must have been of proportionate diameter to receive and sustain the condyles, and surrounded by a large mass of flesh. Both these circumstances would tend greatly to limit the range of motion of the head and neck. But to suit the herbivorous habits of the animal, it must have had some other mode of reaching its food; or the vertebræ must have been elongated in a ratio to their diameter, sufficient to admit of free motion to the neck. In the latter case, the neck must have been of great length, and to support it and the load of muscles about it, an immense developement would be required in the spinal apophysis of the dorsal vertebræ, and in the whole anterior extremity, with an unwieldy form of the body generally. It is therefore more probable that the vertebræ were condensed, as in the Elephant, and the neck short and thick, admitting of limited motion to the head: circumstances indirectly corroborating the existence of a trunk.

4th.—The face is short, broad, and massive, to an extent not found in the Ruminantia, and somewhat resembling that of the Elephant, and suitable for the attachment of a trunk.

Next with regard to the horns:—

There can be no doubt, that the two thick, short, and conical processes between the orbits, were the cores of horns, resembling those of the Bovine and Antilopine sections of the Ruminantia. They are smooth, and run evenly into the brow without any burr. The horny sheaths which they bore, must have been straight, thick, and not much elongated. None of the bicorned Ruminantia have horns placed in the same way, exactly between and over the orbits: they have them more or less to the rear. The only ruminant which has horns similar in position is the four-horned Antelope* of Hindustán, which differs only in having its anterior pair of horns a little more in advance of the orbits, than occurs in the Sivatherium. The correspondence of the two at once suggest the question, "had the Sivatherium also two additional horns on the vertex?" The cranium in the fossil is mutilated across at the vertex, so as to deprive us of direct evidence on the point, but the following reasons render the supposition at least probable:

1st.—As above stated, in the bi-cavicorned Ruminantia, the osseous cores are placed more or less to the rear of the orbits.

2nd.—In such known species as have four horns, the supplementary pair is between the orbits, and the normal pair well back upon the frontal.

3rd.—In the Bovine section of Ruminantia, the frontal is contracted behind the orbits, and upwards from the contraction, it is expanded again into two swellings, at the lateral angles of the vertex, which run into the bases of the osseous cores of the horns. This conformation does not exist in such of the Ruminantia as want horns, or as have them approximated on the brow. It is present in the Sivatherium.

On either supposition, the intra-orbitary horns are a remarkable feature in the fossil: and if they were a solitary pair on the head, the structure, from their position, would perhaps be more singular, than if there had been two additional horns behind.

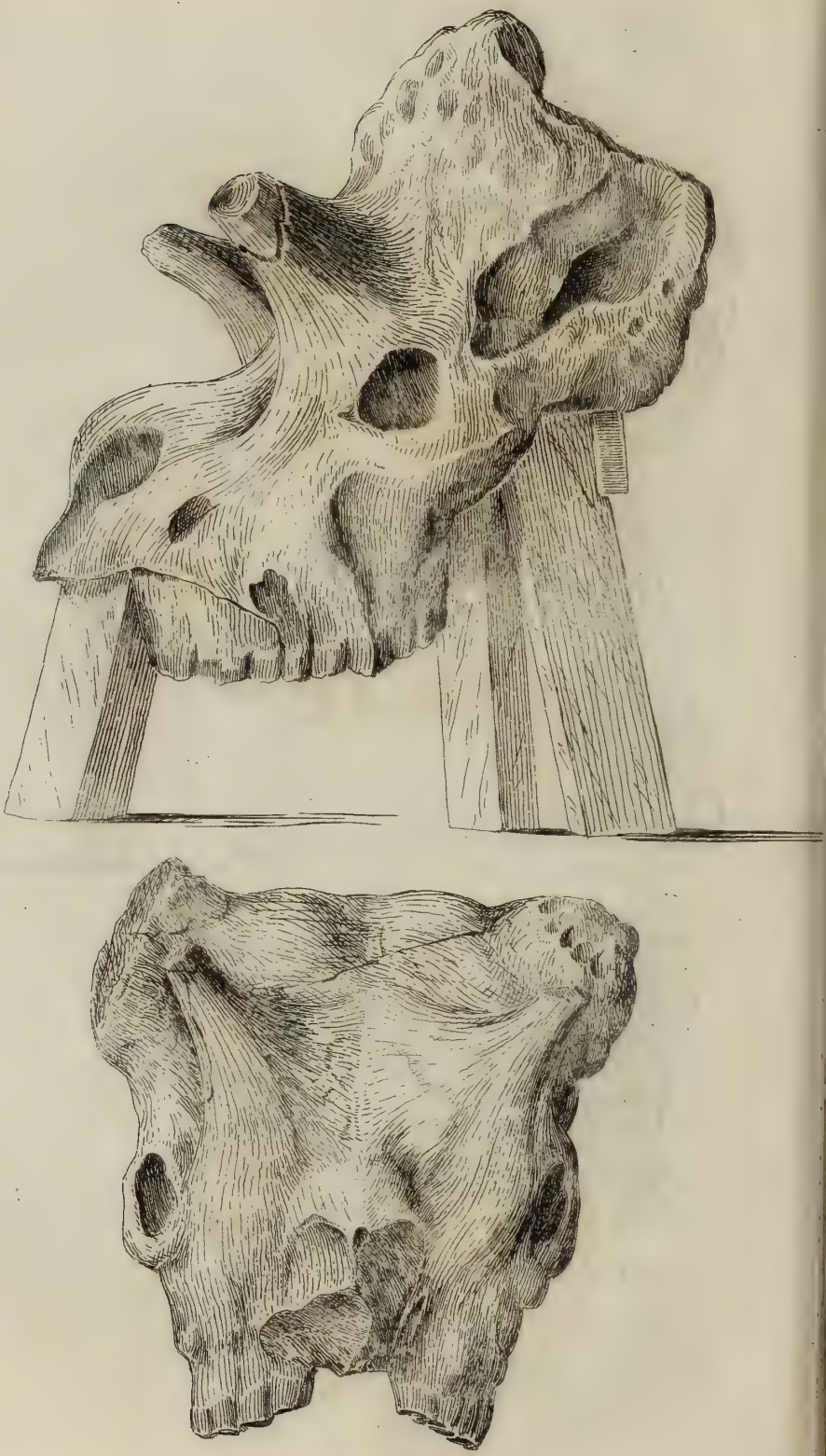
Now to estimate the length of the deficient portion of the muzzle, and the entire length of the head:—

In most of the Ruminantia, where the molars are in a contiguous uninterrupted series, the interval from the first molar to the anterior border of the incisive bones is nearly equal to the space occupied by the molars; in some greater, in some a little less, and generally the latter. In other

* The *Tetracerus* or *Antilope Quadricornis* and *Chekara* of authors.

SIVATHERIUM

on a scale of one-seventh



Etched by Jas Atkinson from drawings by Capt Cautley